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Joseph W. Guenther
Thomas H. Anderson
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June 1991

Center for the Study of Reading

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College of Education
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
174 Children's Research Center
51 Gerty Drive
Champaign, Illinois 61820

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Abstract

Learning outcomes and reading behaviors of 171 sixth graders were investigated while they read expository text and answered adjunct questions. The 2,400-word text was divided into four lessons, and students answered text explicit-, text implicit-, or no questions (a control group) as they read silently and were videotaped. In addition, the placement of questions was manipulated. Some students were allowed to see the questions before they read each lesson, others were not allowed to see the questions until after reading a chapter (but they could not look back in the text to locate answers), and a third group was allowed to see the adjunct questions after each lesson and could look back in the text to locate answers to the questions. After the four lessons had been read and adjunct questions answered, all students were given a comprehension test that included repeated questions that had been asked previously while the students were reading (an index of direct learning) and new questions (an index of indirect learning). The results showed a strong effect for the use of questions on direct learning. Also, there was evidence of indirect learning as shown by students who were not allowed to look back in the text to answer the questions. These students remembered more of the new information than did the students who were given the questions before reading the passage. The results support the use of study guides as an aid to reading and learning information from expository text, especially when students use the strategy of reading first and answering questions later.

HOW STUDENTS READ TO ANSWER QUESTIONS AND HOW THAT AFFECTS THEIR LEARNING

Adjunct questions are questions that accompany a textual segment. The direct effect of such questions refers to their effect on the learning of directly questioned textual material and is well established in the literature, which extends back at least 60 years. Direct effects are tested by "repeated" criterial questions, questions that have been seen and/or answered at least once as adjunct questions. These effects are generally robust under almost any circumstances (Anderson & Biddle, 1975; Andre, 1987; Hamilton, 1985; Rickards, 1979). Readers tend to have a better memory for textual information if they have been questioned about it before, whether the question appears before or after the text. Indirect effects refer to the effect of adjunct questions on the learning of textual material not directly questioned. These effects are tested by "new" criterial questions, which cover textual material not previously questioned by the adjunct questions. Indirect effects have not been consistently found in previous research.

The position in which adjunct questions are placed has a measurable effect on learning. Prequestions, questions read before the text itself, usually have strong positive effects and no indirect effects. In fact, a negative indirect effect is sometimes claimed for prequestions (Anderson & Biddle, 1975; Andre, 1987). That is to say, subjects with prequestions actually show less indirect learning than subjects who read the text and have no adjunct questions. Postquestions, questions read and answered after the text has been read, have a generally positive effect and occasionally a positive indirect effect (Anderson & Biddle, 1975; Andre, 1987; Hamaker, 1986). This study will attempt to demonstrate and explain indirect effects as well as the circumstances that surround them and the cognitive processes which accompany them.

Forward direct effects refer to the learning of textual information that is directly related, usually categorically, to the information questioned in previous textual segments. For example, if a reader has been questioned exclusively about names or about dates after having read previous textual segments, it is likely that she or he will be reading subsequent with an eye for names or for dates, regardless of whether questions about names or dates will actually follow that textual segment.

Forward indirect effects refer to the learning of information within textual segments that directly follow segments of text accompanied by adjunct questions. These effects refer to a sort of carrying forward of that reading strategy and those cognitive processes which accompanied the reading and learning of previous textual segments. This study will also attempt to demonstrate and explain forward indirect effects, the cognitive processes responsible for them, and the circumstances under which they are likely to occur.

Another issue that has been under much scrutiny has been that of "levels" of questions, of the effect of higher order questions versus lower order ones on learning. Under certain circumstances, higher level questions have been found to be more effective in learning certain kinds of information than have lower level questions. In his meta-analysis, Hamaker (1984) found a generally favorable effect for higher order questions on repeated, related and unrelated higher order learning. He also found that lower order factual questions are superior to higher order questions on repeated and related factual questions, although he also found a trend toward a favorable effect for higher order questions on the learning of factual information when compared to the learning of a no-questions group.

To further muddy the waters, it is not clear that the effects of adjunct questions on the learning of grade school children are the same as they are on mature adult readers, the subjects of most of the 100 or so adjunct-questions studies that have been carried out since 1929.

What cognitive processes are operative, and what causes them to vary with the cognitive level of the question or with the position of the question relative to the text? What reading circumstances will encourage one kind of learning and depress another? These questions also have been the subject of considerable debate at least since Rothkopf's landmark studies (Rothkopf, 1966; Rothkopf & Billington, 1974).

Adjunct questions read before the text, as noted above, generally have been found to have a strong positive direct effect. However, they have often been found to have a measurably negative effect on the learning of unquestioned textual material. It has been suggested that this is because the reader tends to overfocus on reading for the answers to those questions at the expense of other textual material (Duchastel, 1983).

Adjunct questions read after the text, as noted above, are also generally found to have a strong positive direct effect. In some circumstances, postquestions have been found to have a positive indirect effect as well. Gustafson and Toole (1970) and Duchastel and Nungester (1984) claim that indirect effects will occur only when students are not allowed to look back into the text for answers. Gustafson and Toole hypothesize that this is because when a reader knows she will have another chance to read the text, she has less reason to be careful when reading it in the first place. Therefore, when lookbacks are not permitted and the reader knows that a question will follow, she will read all textual material more carefully as in preparation for a test.

Duchastel (1983) attributes the indirect effect for postquestions to the backward mental review postulated by Rickards (1979) and others. In other words, when a reader encounters questions after a textual segment he is not allowed to reread, the reader must mentally review all the material within that textual segment, whether or not there are questions about it, in order to find the answer for that question within his memory for that text. This mental review theoretically heightens memory for all the textual ideas that have just been reviewed mentally, not simply those ideas specifically under question.

Two similar hypotheses are in competition to explain the indirect forward effect. One explanation has it that if a reader knows (or expects) that he is going to be questioned about an upcoming segment of text, then he will read that segment as if in preparation for a test, whether or not, of course, there actually is such a test. Another explanation has less to do with reader expectations than with simple momentum: A reader will often carry forward a certain type of textual processing simply as a sort of forward momentum, regardless of expectations, regardless of knowledge or suspicions about what will be in or what will follow the next segment of text. This second explanation has more to do with what a reader actually does than with what a reader expects to do or to encounter.

As suggested above, findings regarding indirect effects have been ambiguous and sometimes contradictory. Some studies (Hiller, 1974; Robinson, 1975; Rowls, 1975) have found no indirect effect for postquestions at all while other studies have (Rickards & DiVesta, 1974; Rothkopf, 1966; Rothkopf & Billington, 1974).

One problem in evaluating many adjunct-questions studies lies in determining exactly under what circumstances students read to answer their questions. From reading many of these studies, one cannot always determine whether lookbacks were permitted, encouraged, discouraged, or forbidden. Furthermore, one cannot know what students actually did when they answered their questions but only what they might have done, and frequently there is considerable latitude permitted or possible.

It is possible that the ambiguity of earlier findings regarding indirect effects stems from the fact that subjects in certain conditions might have, in fact, taken any of several tacks to answer their questions. Some of them might have read questions before reading the text simply because it was possible, even though they were in a postquestions group. Some of them might have looked back into the text after reading and some of them might have read questions and answered from memory. Some might have simply read the text to find answers to questions. Circumstances might have permitted groups to have

within them subjects who, in fact, followed a variety of strategies in answering their questions. Groups therefore might not have been as homogeneous as their authors intended them to be. Often, one cannot know what students in groups actually did when they answered their questions, but only what they might have done, and frequently there is considerable latitude permitted or possible.

The purpose of this study is to answer the following questions. What strategies do students follow when they answer adjunct questions? Which of these strategies will result in direct learning and which will result in indirect learning? What is the effect of question position on direct and indirect learning? What is the effect of question level on direct and indirect learning? How does looking back into the text affect direct and indirect learning? Under what circumstances will an indirect forward effect be found? Does ability interact with any of these factors, and how do these factors interact with each other? Are the effects found to be true for adult readers also true for school children? What cognitive processes accompany and cause these effects to occur?

To learn how those procedures affected the students' direct and indirect learning, we observed the procedures sixth-grade students followed when they read to answer questions. The study was designed so that we could tell exactly what procedures students followed. We had a certain number of students who had no choice but to follow certain procedures when answering their questions, and these conditions were strictly enforced so that there was no latitude in some experimental conditions. In other conditions, when latitude was allowed, we could determine, through video monitoring of students as they read, exactly what they did when they answered their adjunct questions.

Method

Subjects

Subjects were 171 sixth-grade students, 93 males and 78 females, drawn from two junior high schools in small towns located in a largely agricultural region in the midwest. The students' reading ability, as measured by the reading comprehension subtest of the Stanford Achievement Test, Seven Plus (1986), ranged from third grade to post high school. Mean grade equivalency on this test one month before the study was tenth grade (10.2) at a time when the students' actual grade in school was 6.7.

Materials

A four-lesson, 2,400-word chapter entitled "The Celts" taken from a sixth-grade textbook *Social Studies* (Scott, Foresman, 1979, pp. 340-347) was used as the experimental text. This textbook was not currently used in either of the schools. Although the subject matter was expected to be relatively unfamiliar to most sixth graders, the criterion tests were administered in a pilot study to a class of seventh graders from one of the two schools to determine that the content was, in fact, unfamiliar to most students of middle-school age. The text was prepared for videotaping by placing each paragraph and a large page number on a separate page.

Adjunct Questions

Two sets of adjunct questions were prepared, textually explicit and textually implicit, after Pearson and Johnson (1978). Each adjunct question was printed on a separate page. A large identifying number appeared on each page as well.

Textually explicit (TE) questions. One set of textually explicit (TE) questions was constructed for the first three of the four lessons according to the following guidelines: The answer to each question had to be explicitly stated in the text and included within one sentence (Pearson & Johnson, 1978). The questions were then placed in the rank order of their relative structural importance by five independent judges.

The six questions chosen to be most important to each of the three lessons were then paired according to the order of their importance, with questions 1 and 2 being on the same tier, 3 and 4 being on the same tier, and so on. They were then randomly assigned to either question set A or question set B. For example, question set A for Lesson One consists of questions 1, 4, and 5. Question set B consists of questions 2, 3, and 6. Questions were counterbalanced in this way so that each student would have three adjunct questions for each of the first three lessons, with all six questions again appearing on the TE criterion test. Questions that were adjunct questions for the set A questions group, and therefore repeated questions on the TE criterion test, were new items for the set B group and vice versa. Performance on the nine new items on the TE criterion test (three questions from each lesson) was seen as a measure of indirect learning, and performance on the nine repeated items on the TE test was seen as a measure of direct learning.

Subjects receiving textually explicit questions received three questions for each of the first three lessons, and no questions for the fourth lesson. Six questions from Lesson Four that appeared on the TE criterion test were seen as a measure of indirect forward effect.

Textually implicit (TI) questions. One textually implicit "inferential/summary" (TI) question was written for each lesson. By definition, a textually implicit question requires information from two or more sentences in the text to answer it (Pearson & Johnson, 1978). These questions were intended to be broad enough to cover most of the textual material in each lesson. Two questions were compare and contrast questions, and a third asked the readers to judge the importance of an important figure in the tribe, the Druid. One of these questions (from Lesson Two) was repeated as a criterion TI test question. Subjects received no adjunct question for Lesson Four. An inferential summary question for Lesson Four was on the criterion TI test as a measure of indirect forward effect.

Criterion tests. The first part of the criterion test was the same TI question that subjects in the TI groups saw as an adjunct question for Lesson Two, and was considered to be a TI test of a direct effect for subjects in the TI groups, and a TI test of indirect effect for subjects in the TE groups. The second part of the criterion test was a TI question covering the material in Lesson Four of the chapter, and was considered to be a TI test of indirect forward effect. There was no TI question from either Lesson One or Lesson Three on the criterion test.

The third part of the criterion test was a 24-question short-answer TE test that consisted of six items from each lesson, including Lesson Four. Items were counterbalanced so that for subjects in the TE groups, half of all the items were new and half were repeated. In that way, a measure of both direct and indirect effects could be obtained for subjects in both question sets, without a bias for either question set. All the TE items were new for subjects in the TI and Read-Only groups, and thus a TE measure of indirect effect for those subjects. The six TE items from Lesson Four were new for all subjects and were considered as a measure of an indirect forward effect.

Experimental Treatments and Experimental Design

Subjects were divided into two ability groups, above and below the median, according to their scores on the reading comprehension subtest of the Stanford Achievement Test, which had been administered that semester in both schools. Subjects in the below-average group ranged from a score of 17 correct answers out of a total of 60 questions on the test (GE = 3.2) to 47/60 (GE = 10.0), while subjects in the above-average group ranged from 48/60 (GE = 10.5) to 60/60 (GE = Post High School). The median was 48. The subjects from each group were randomly assigned to treatment groups, and then randomly assigned to receive either TE or TI adjunct questions.

Assignment Conditions

Subjects were assigned to one of four conditions:

Lookbacks-Not-Allowed. Subjects in the Lookbacks-Not-Allowed (LBNA) group read each lesson first, then were given a set of adjunct questions (either TE or TI) when they were finished reading. The text was removed before they were given their questions so that lookbacks were not possible. The two levels of this condition are referred to as the Lookbacks-Not-Allowed TE and TI groups.

Lookbacks-Allowed. Subjects in the Lookbacks-Allowed (LBA) group read each lesson first, then were given a set of adjunct questions, either TE or TI. The text was not removed when they were given their postquestions, so that lookbacks were possible. The two levels of this condition are referred to as the Lookbacks-Allowed TE and TI groups.

Same-Time. Subjects in the Same-Time (ST) group received both their lesson and adjunct question(s) at the same time. The decision of whether to read the question or the lesson first was left to each student without comment by the researchers. The two levels of this condition are referred to as the Same-Time TE and TI groups.

Read-Only. Subjects in the Read-Only (RO) group received the lesson to read but no adjunct questions. This condition is referred to as the Read-Only group (see Figure 1).

[Insert Figure 1 about here.]

Data Collection

To determine which procedure each student actually followed, each was videotaped individually as he or she read each lesson and responded to each adjunct question. The videocamera was positioned in front of subjects so that each page was in view as they read it. A clock showing real time appeared at the bottom of the video screen to provide a record of how much time was spent on each paragraph and on each question.

Reassignment of Subjects into Processing Groups

Subjects were divided into the following processing groups according to the strategies they *actually* used to read the text and answer their questions. The analyses that follow will use these two major groupings: assignment condition and processing group. Criteria for dividing subjects into processing groups follow.

No Lookbacks. Subjects in the No Lookbacks (NL) processing group are characterized as follows: These subjects read the entire lesson first, and then answered their questions entirely from memory without looking back into the text. This group included all subjects in the Lookbacks-Not-Allowed assignment condition, as well as some subjects in the Lookbacks-Allowed and Same-Time assignment conditions. The two levels of this condition are referred to as the No-Lookbacks TE and TI processing groups (NLTE and NLTI).

Lookbacks. Subjects in the Lookbacks (LB) processing group are characterized as follows: They read the entire lesson, then read their question(s) and searched for answer(s) one at a time. This group included some subjects in the Lookbacks-Allowed and Same-Time condition. The two levels of this condition are referred to as the Lookbacks TE and TI processing groups (LBTE and LBTI).

Search. Subjects in the Search (S) processing group are characterized as follows: They did not read the entire lesson through first, but rather read each question and searched for answers to each question.

These subjects came exclusively from the Same-Time assignment condition. A characteristic behavior for such subjects was that they would begin writing as they found information relevant to each question. For the TE question treatment, this meant that subjects would read a question, then search through the pages until they found a relevant paragraph, then write an answer, then return to the question set and read the next question, search again, write an answer, and so on.

For the TI question treatment, this meant that most subjects would read the question, search for a relevant paragraph, write part of their answer, search some more, write some more, then search and write until finished. A minority approach for subjects in this question treatment was to read the question, search for the relevant paragraphs and read more than one relevant paragraph before beginning to write an answer.

The identifying characteristic for most of these subjects is that they did not read the text through in its entirety before searching and writing an answer. A secondary characteristic of most subjects was that they checked the question as they searched to answer it. A total of 19 subjects (out of 73) did not write before reaching the end of the lesson on one or more lessons. However, most of these subjects checked the question as they read. Eight of these subjects for one lesson or more neither wrote before finishing the lesson nor checked the question as they read. Six of these, for one lesson or more, read the question before reading the lesson, and then did not read the question again until reaching the end of the lesson, when they reread the question and started once more to search the text for an answer.

Two subjects, for one or more lessons, read the question first, then read the entire lesson, and then wrote an answer from memory without again looking back into the text. One student did this for two lessons, and for the third lesson read the entire text, wrote from memory, and then looked back in the text. The other student read the question and then the entire text and then wrote from memory for one lesson only. For the other two lessons, she followed this pattern and then looked back into the text for additional information. Both subjects were characterized as Search subjects for all three lessons.

The two levels of this condition are referred to as the Search TE and TI processing groups (STE and STI).

Read-Only. This group included all subjects in the Read-Only (RO) assignment condition.

Scoring

The same scoring procedures were used for both adjunct-question and criterion-test answers; however, the TE and TI questions had to be scored differently.

TE questions. To analyze answers to adjunct TE questions, completeness and correctness of response were determined a priori and answers were judged accordingly. One point was awarded to each answer judged to include the complete answer. Partial credit was awarded for incomplete answers. For example, if, in response to a question that asked for the jobs done by a peasant woman a subject listed 4 of the 7 jobs given in the text, that subject was awarded one point. If the subject listed 1 job, he or she received 1/4 point. An independent rater scored a random sample of TE criterion tests. The interrater reliability was r = .889.

TI questions. Idea units relevant to answering the TI questions were determined a priori. This list of idea units was used to score idea units that appeared in responses to the inferential/summary criterion question. On answers to inferential/summary questions, 1 point was awarded to each correct and complete idea unit contained in each answer. The objectivity of this scoring system was then assessed by having an independent rater score a random sample of these responses. The interrater reliability was r = .836.

Statistical Analyses

Analyses of dependent measures. Because subjects would require at least one lesson to adjust their procedures to their reading circumstances, only data from Lessons Two, Three, and Four were used in the analyses. Lesson One was considered a practice or orientation lesson.

Repeated items on the criterion TE test that were based on questions taken from textual information in Lessons Two and Three served as a measure of the direct effect of TE questions for Lessons Two and Three. Only subjects who received TE adjunct questions could be said to have experienced a direct effect of those questions.

New items on the criterial TE test that were based on questions taken from textual information in Lessons Two and Three served as a measure of the indirect effect of TE questions for Lessons Two and Three. For subjects who had received a TI adjunct question or no adjunct question, all TE criterial questions from Lessons Two and Three were new ones, and thus served as a measure of an indirect effect for Lessons Two and Three.

All criterial items from Lesson Four were new to all subjects. Therefore, the TE items on the criterial test that related to Lesson Four served as a measure of an indirect or general forward effect.

Of the two TI questions asked on the criterial test, one was a repeated question from Lesson Two, which served as a measure of direct effect for subjects who had received TI adjunct questions and a measure of indirect effect for subjects who had received TE adjunct questions. The second TI criterial question covered information discussed in Lesson Four, and therefore served as a measure of an indirect or general forward effect.

Because of the unbalanced design, all possible interactions were not logical. Therefore, all higher order interactions and main effects were tested for significance using SYSTAT (Wilkinson, 1987). According to this method, any significant interactions and main effects were retained and used in the final regression equation. The dependent measures were repeated TE questions for Lessons Two and Three, new TE questions for Lessons Two and Three, new Lesson Four TE questions, the repeated Lesson Two TI question, and the new Lesson Four TI question. The independent measures were reading ability, lesson, adjunct-question type, and processing group or assignment condition. Bonferroni post hoc comparisons (Wilkinson, 1987) were used to test the differences among group means.

Results

Use of Adjunct Questions: Strategy Selection

Most subjects consistently used the same procedure for each lesson, although there were exceptions. These 16 exceptional subjects, while never changing assignment condition, were reassigned to different processing groups from one lesson to the next.

All but one of the subjects in the Lookbacks-Allowed Condition who had the TE question treatment did look back in the text (see Table 1). Most of the LBA subjects with the TI question treatment looked back. A Chi-squared test showed that the proportion of TE subjects in the Lookbacks-Allowed condition who chose to look back versus those who did not look back was significantly greater than the proportion of TI subjects in the Lookbacks-Allowed condition who chose to look back. [Chi-squared (1) = 11.53 (p = .0007).]

[Insert Table 1 about here.]

The most popular choice for subjects in the Same-Time condition was to search for answers, by a slim non-significant margin over the strategy of reading the text first and then looking for answers. There was no significant difference by question treatment (TE or TI) in proportion of strategy chosen by subjects in this assignment condition.

The number of subjects in each assignment varied slightly from lesson to lesson because of either incomplete video data due to electronic failure or because of incomplete adjunct question or criterion data.

Learning Outcomes: Main Effect by Question Set

As stated earlier, questions were ranked according to difficulty level as determined by an independent panel of judges. They were then paired on tiers by ability level and randomly assigned to either Question Set A or Set B. Subjects were randomly assigned to either Set A or Set B for their adjunct questions. Both sets appeared as criterion questions, and thus adjunct questions were counterbalanced so that what was new for half of the TE subjects was repeated for the other half, and vice versa.

The level of difficulty between Set A and Set B criterion items was compared for the Read-Only condition subjects and found not to differ significantly.

Nevertheless, there was a significant main effect for question set on repeated items only [$F(1,146) = 6.70, p = .01$.] There was no main effect for question set on new items. This indicates that while the items might be roughly equivalent as criterion items, one set (Set A) was more memorable than the other (Set B) as a criterion item if it had been seen previously as an adjunct question item.

Learning Outcomes: Direct Effect

Several tests of the direct effects of adjunct questions were available in this study. One test was the difference between the grand mean for all TE subjects on repeated criterial items from Lessons Two and Three compared with that on new criterial items. The average score on repeated items, 1.44 out of 6, was significantly higher than the average score on new items, .75 out of 6 [$F(1,149) = 77.286, p < .00001$].

Another test of the direct effect can be seen in a comparison between TE and TI subjects on items that are repeated for TE subjects and new for TI subjects and vice versa. On repeated TE items, TE subjects significantly outperformed TI subjects [$F(1,332) = 43.141, p < .00001$]. On the repeated TI criterion question, TI subjects significantly outperformed TE subjects [$F(1,331) = 8.16, p < .005$] as a measure of direct effect. See Table 2 for a comparison of means.

[Insert Table 2 about here.]

Direct Effect by Assignment Condition

Results from the analysis of repeated TE criterion items show that subjects in the Lookbacks-Allowed condition significantly outperformed those in the Lookbacks-Not-Allowed [$F(1,175) = 6.09, p = .015$] and the Read-Only [$F(1,175) = 28.32, p < .00001$] conditions. Subjects in the Same-Time condition outperformed those in the Lookbacks-Not-Allowed [$F(1,175) = 4.80, p = .03$] and Read-Only [$F(1,175) = 28.32, p < .00001$] conditions. See Table 2 for a comparison of means.

There was a significant ability by assignment condition interaction [$F(3,183) = 3.53, p = .016$). The advantage enjoyed by above-average subjects over below-average subjects was significantly greater for the Lookbacks-Allowed and No-Lookbacks assignment conditions than it was for the Same-Time

condition. In other words, below-average subjects seemed to do better in the Same-Time condition relative to above-average than they did in the other two treatment conditions.

On the repeated TI question, there was no direct effect by assignment condition.

Direct Effect by Processing Group

On TE repeated items, subjects in the Lookbacks Processing Group outperformed those in the No-Lookbacks [$F(1,186) = 7.78, p = .006$] and the Read-Only [$F(1,186) = 35.90, p < .00001$] groups. Subjects in the Search group outperformed those in the Read-Only [$F(1,186) = 25.44, p < .00001$)] and the No-Lookbacks [$F(1,186) = 4.09, p = .045$] groups. Subjects in the No-Lookbacks group outperformed those in the Read-Only group [$F(1,186) = 12.38, p = .0005$]. There were no two-way or three-way interactions by ability, lesson, or processing group on repeated TE items. See Table 2 for a comparison of means.

On the repeated TI question, there was no direct effect by processing group interaction.

Learning Outcomes: Indirect Effect

Indirect Effect by Assignment Condition

On new TE items, subjects in the Lookbacks-Not-Allowed condition only marginally outperformed those in the Same-Time [$F(1,326) = 2.87, p = .091$] and the Read-Only conditions [$F(1,326) = 2.83, p = .094$]. Subjects in the Lookbacks-Allowed condition significantly outperformed those in the Same-Time [$F(1,326) = 11.27, p = .0009$] and Read-Only [$F(1,326) = 8.18, p = .0045$] conditions. See Table 2 for a comparison of means.

There were significant assignment condition by question type by ability [$F(3,326) = 7.94, p = .00004$] and lesson by ability [$F(1,326) = 4.12, p = .04$] interactions. Lower ability subjects with TE questions seemed to perform best relative to higher ability subjects in the Lookbacks-Not-Allowed condition.

The ability by lesson interaction shows that on Lesson Two, lower ability subjects with TE questions in the Lookbacks-Not-Allowed condition did slightly better than higher ability subjects in that condition. On Lesson Three, however, those same subjects reversed their order, with higher ability subjects outperforming lower ability subjects, as would be expected.

On the TI criterion measure, there was no indirect effect by assignment condition interaction.

Indirect Effect by Processing Group

On new TE items, subjects in the No-Lookbacks group outperformed those in the Search [$F(1,336 = 7.43, p = .007$] and Read-Only [$F(1,336) = 4.53, p = .034$] groups. The Lookbacks group significantly outperformed the Search [$F(1,336) = 3.86, p = .05$] group and was higher than the Read-Only [$F(1,336) = 2.32, p = .129$] group at a level of confidence which approached significance. There were no two-way or three-way interactions by lesson, processing group, or question type. See Table 2 for a comparison of means.

On the TI criterion measure, there was no indirect effect by processing group interaction.

Indirect Forward Effect by Assignment Condition (Lesson Four)

Subjects were assigned into processing groups for Lesson Four according to the strategies they used on Lesson Three. There were no significant effects by processing group or question type on the TI criterion measure, though subjects in the No-Lookbacks group outperformed those in the Search [$F(1,162) = 2.407$, $p = .128$] and the Lookbacks [$F(1,162) = 2.449$, $p = .12$] groups at levels of confidence that approached significance.

Indirect Forward Effect by Processing Group (Lesson Four)

On the TE criterion items for Lesson Four, the No-Lookbacks group outperformed the Lookbacks [$F(1,162) = 11.446, p < .001$], the Search [$F(1,162) = 5.407, p = .021$], and the Read-Only [$F(1,162) = 5.272, p = .023$] groups. See Table 3 for a comparison of means.

There were no interactions of forward effect by assignment condition or processing group.

[Insert Table 3 about here.]

Discussion

One question answered by this study is which of the self-selected strategies used by the students in this study would be most effective for learning directly questioned information. Another question answered is which of these self-selected strategies are most effective for learning information not directly questioned.

While most studies only provide results of what students learned under circumstances over which they have little or no control, this study allows an interesting comparison: What are the group differences in learning under assigned conditions? What are the group differences under the selected processing strategies and how do these two comparisons contrast with one another?

Strategy Selection

Previous research has given little information about what reading strategy students would naturally select when given a choice. The teachers at the two schools involved in the study were not accurate in their prediction about what students would choose to do, expressing their belief that a large majority of the students in the Same-Time assignment condition would read simply to answer the questions. However, this was not the case. No more than half the students did this during any one lesson, although there was a minor trend for students to do so as they progressed from Lesson One to Lesson Three. However, a surprisingly large number of students read the text all the way through and then looked for answers in the text, possibly reflecting the way they had been taught to read in elementary school.

The mean ability levels of the processing groups students selected themselves into did not differ, nor did their ability levels differ within those processing groups according to what assignment condition students were in originally. For example, students in the No-Lookbacks processing group who were originally in the Lookbacks-Not-Allowed assignment condition scored no better on their SAT reading comprehension tests than those who were originally in the Same-Time or Lookbacks-Allowed assignment conditions. Therefore, one cannot surmise that one group was more strategic or more metacognitively aware than any other. For example, it's probably not true that subjects in the No-Lookbacks group didn't look back because they already knew the answer. Perhaps the decision to read the text all the way through and then to look back for answers versus reading the text simply to find answers was simply a matter of perceived convenience on the part of the students. Some students might be more practical or more task-oriented than others.

It is interesting to note that, while only a small percentage of TE or TI students chose not to look back into the text to answer their questions when given the choice, this percentage of No-Lookbacks is greater for TI students than for TE students. Is it possible that this is related to the specificity of the questions? The TE questions ask for specific answers which might need to be looked up, while the TI questions require a more integrative answer, drawing from a variety of textual locations. Also, TI questions tend to require a more reflective answer, one that might be better answered by thinking about the entire lesson as a piece than by referencing specific textual segments.

Direct Effect

The direct effect of adjunct questions refers to the learning of the answers to those questions asked previously. As noted by earlier investigators (Anderson & Biddle, 1975), the direct effect of questions has been robust in most previous adjunct questions studies, and this one is no exception. All groups with adjunct questions significantly outperformed students without questions on direct learning, that is the retention of the answers to those questions when tested on them 24 hours later. The Search and Lookbacks groups outperformed the No-Lookbacks group as well, suggesting that it is helpful to have the text in front of a reader while he or she is answering questions about textual information, and that it is more helpful to use the text while answering questions than it is to answer from memory. However, it is the indirect effect of adjunct questions that has been the most controversial.

Indirect Effect

The indirect effect of adjunct questions refers to the learning of information not previously queried by the adjunct questions. The indirect effect on learning shown for the No-Lookbacks group during Lessons Two and Three, significantly outperforming both the Search and Read-Only groups on new TE questions, leads one to argue for an indirect backward review, a non-selective backward mental review triggered by the post-questions, to explain this effect (Anderson & Biddle, 1975; Frase, 1967). During this review, all information previously read and temporarily stored must be reviewed by the reader to decide which information was relevant to the question and which was not. The heightened attention given to the textual information covered during this review results in better retention of both directly questioned information and information not questioned when compared to a read-only or a search group. This effect is weakened when subjects look back in the text to find answers, and is non-existent when subjects search for answers without reading the text first.

A competing explanation is that this indirect effect can be explained as a result of a forward effect: those students who did not look back during Lesson One read Lesson Two more carefully, anticipating that they would not be able to (or, for those who chose not to look back, would choose not to) look back into the text. However, a forward effect cannot of itself explain the indirect learning experienced by the No-Lookbacks processing group. If the forward effect alone is responsible for indirect learning, then the Lookbacks-Not-Allowed assignment condition group would have experienced significantly greater indirect learning than the Read-Only Group. It is the Lookbacks-Not-Allowed subjects alone who read a lesson with the understanding that they would not be *able* to look back into the text; they should be the only subjects for whom a forward facilitative effect was demonstrated. Yet this group does not experience a significant indirect effect. It is only when the data from those students who were assigned to the Lookbacks-Allowed and Same-Time conditions but opted not to look back, were combined with data from students in the Lookbacks-Not-Allowed assignment condition (to become the No-Lookbacks processing group) that we see an indirect effect attributable to no lookbacks.

Perhaps one way to pose the question is to consider whether it is what readers are able to do and what they believe they will be able to do or what they actually do which more influences their indirect learning. Specifically, Gustafson and Toole (1970) postulate that when students know they will be able to reread the text, they will read less carefully than students who know they will not have a second chance at it. Duchastel (1983), however, hypothesizes that it is the actual processing that occurs during

a backward mental review, in the absence of the actual text itself, that strengthens retention of textual information, both questioned and non-questioned (or incidental).

There is a subtle but important distinction here. The findings reported above would have to support the latter point of view. It is more what students actually do (as reflected by the processing group they are in) than what they are able to do or know they can do (as reflected by the assignment group they are assigned to) which determines their indirect learning. If we are to accept Gustafson and Toole's explanation, then we are really accepting the forward effect explanation for why indirect effects occur: It is that students know they will not be able to read the text a second time which determines their indirect learning. But if this were the sole or most important explanation, then it would be the Lookbacks-Not-Allowed assignment condition that would have the significantly superior forward effect for Lesson Four, for it is they alone who have reason to believe there might be questions after Lesson Four and that they will not be able to reread the lesson if there are. Students from the Lookbacks-Allowed assignment condition might believe there will be questions, but they know that if there are, they will have access to the text. Same-Time students have every reason to believe that, since they did not get questions with Lesson Four, as they did with every previous lesson, they would get no questions. However, there is no advantage at all for Lookbacks-Not-Allowed students.

There is, however, an advantage for students in the No-Lookbacks processing group, composed of students who should have thought there would be questions at the end of the lesson (Lookbacks-Not-Allowed students), students who might have expected questions but would have expected access to the text (Lookbacks-Allowed students), and students who should not have expected questions at the end of the lesson (Same-Time students). The only thing these students have in common is the way they processed the text: none of them looked back into the text when they answered their questions for the previous lesson, Lesson Three. This argues that it is more what students did, the processing they did, than it is what they thought they could do, that influenced their learning.

The same argument can be applied to indirect learning for Lessons Two and Three. If it is primarily a forward effect that is driving indirect learning, then it is those students who are in the Lookbacks-Not-Allowed assignment condition which should enjoy significantly greater indirect learning. Those in the Lookbacks-Allowed assignment condition in particular should not, if we accept the explanation proposed by Gustafson and Toole (1970), experience any indirect learning. It is a student in this latter group who would know "he can reread the text and review the questions as often as he likes . . . there is no longer a good reason for the student to concentrate any harder on the text than he would if not aided by adjunct questions." A student in the Lookbacks-Not-Allowed group, on the other hand, "realizes he will have but a single chance at the material and is either told or soon becomes aware that questions of unknown content await him from time to time."

However, the results are just the opposite of what this hypothesis would predict. It is students in the Lookbacks-Allowed condition who experience indirect learning and students in the Lookbacks-Not-Allowed condition who do not. On the other hand, results confirm the hypothesis of Duchastel (1983) that indirect learning is due to backward mental review. Students in the No-Lookbacks processing group experience significantly more indirect learning than the Read-Only group while students in the Lookbacks processing group do not. This would lend strength to the notion that it is the indirect backward mental review and what students do, rather than a forward effect resulting from reader expectations, what they know they can and can't do, that affects their indirect learning.

Direct learning, too, differed by processing group, by what students actually did when they read to answer their questions. The Lookbacks subjects significantly enhanced their memory for questioned material relative to that of No-Lookbacks subjects, resulting in a significantly greater direct effect than the No-Lookbacks subjects. Temporarily stored questioned material is apparently rendered more memorable by this intensive rereading specifically to answer a question about it, as evidenced by the advantage the Lookbacks subjects had over the No-Lookbacks on direct learning. Lookbacks subjects also seem to have had an advantage on indirect learning which approached statistical significance over

Search and Read-Only subjects. Any temporarily stored indirectly questioned information is apparently not completely dumped by the Lookbacks subjects.

Subjects in the Search group, at the other extreme from the No-Lookbacks subjects, selectively attend only to material directly questioned and, apparently, deliberately ignore non-questioned material. Selective attention causes one not only to focus on the essential, but also to screen out non-essential stimuli. The Search group functioned much like the pre-questions groups of earlier studies. The Search group's direct effect was significantly greater than that of the No-Lookbacks group, and conversely the indirect effect for the No-Lookbacks group was significantly greater than that of the Search Group.

These findings support the speculations of Gustafson and Toole (1970) and Duchastel and Nungester (1984) that, under ecologically realistic conditions, an indirect effect should not be expected. The ambiguity of previous research regarding the indirect effect might be explained when one considers that, in earlier studies, groups were analyzed according to what they were permitted to do rather than according to what they actually did. For example, it might be that, in earlier studies, search subjects were not separated from subjects who first read the text all the way through and then read for answers. Quite possibly, in these two earlier studies, subjects were encouraged by the circumstances of their assignment conditions to simply read relevant material in order to pass a test. Such task orientation can lead students to overfocus in favor of questioned material at the expense of all other textual material, as the Search subjects did in this study. An inclusion of students who searched into what is nominally a Lookbacks-Allowed group would be expected to depress the indirect learning of that group. Perhaps the question of whether letting students look back supresses indirect learning, as suggested by the above researchers, has not truly been answered.

Interestingly, subjects in the Lookbacks-Allowed assignment condition outperformed those in the Same-Time and Read-Only conditions on indirect learning. A revealing comparison can be made between the differences among the assignment conditions and the differences among the processing groups. Subjects in the No-Lookbacks assignment condition did not significantly outperform those in the other conditions on indirect learning. However, the No-Lookbacks processing group, composed as it was of all students who did not look back in the text to answer questions, did significantly outperform the Search and Read-Only processing groups. The indirect effect for the Lookbacks-Allowed assignment condition, however, was significantly greater than it was for the Same-Time and Read-Only conditions.

It seems apparent that the No-Lookbacks processing group was strengthened in its indirect effect by the inclusion of subjects from the Lookbacks-Allowed and Same-Time assignment conditions who, in fact, did not look back in the text. At the same time, the indirect effect for these two conditions would have been strengthened by the inclusion of these subjects who did not look back and who thus reaped the benefits of the indirect backward review.

The difference between assignment group and actual processing group reported here might explain ambiguous findings from earlier research. Possibly the indirect effect for the lookback condition in previous studies was strengthened by the inclusion of subjects who selected themselves into a No-Lookbacks processing group. Similarly, earlier studies that included a Lookbacks-Allowed condition might have had many students who read simply to prepare for a test as cued by study guide adjunct questions. These subjects would correspond to the Search subjects of this study. Unfortunately, this cannot be confirmed, because previous studies did not (as far as a reader can judge) ascertain whether or not subjects did what they were supposed to do, but only that they worked within the limitations imposed on them, which gave them considerable latitude. Sometimes, in fact, it is difficult to know exactly what subjects were allowed to do and/or what the conditions under which they read actually were.

Indirect Forward Effects

Results from Lesson Four show that subjects who did not look back in the text in answering questions for Lesson Three did significantly better than all other groups on Lesson Four TE criterion items. The forward effect is arguably attributable to the more careful attention to the text given by the No-Lookbacks subjects, and confirmatory of earlier hypotheses of Frase (1967) and Rickards (1979). Most of the subjects in this study had no reason not to expect adjunct questions at the end of Lesson Four, and they knew they could not look back. Lookbacks subjects might have expected questions, but would have expected access to the text again; hence, they could afford to read less carefully. Search subjects, receiving no questions with the text as they had for the first three lessons, might have concluded that they were in effect "done for the day," and didn't need to read the rest of the text very carefully. Furthermore, there were no differences in time spent by these groups, so any differences for Lesson Four learning must have been attributable to processing differences.

Of course, as discussed earlier, reader expectations alone cannot account for the differences in the indirect learning based on Lesson Four, and do not explain the indirect learning of those students who had not been in the Lookbacks-Not-Allowed assignment condition and yet did not look back into the text during Lesson Three. The inclusion of these students greatly strengthened the indirect forward effect of the No-Lookbacks processing group, and yet these students could not have expected questions at the end of Lesson Four (Same-Time) or would have expected to be able to again reread the text if there were questions (Lookbacks Allowed). A certain carrying forward of whatever processing that had been done during Lesson Three must also enter into the explanation for whatever learning was accomplished from Lesson Four.

TI vs. TE Adjunct Questions: Which Are More Effective?

Students who answered TI adjunct questions were expected to have an advantage on indirect learning over those who answered TE questions, but apparently there was no such advantage. One is tempted to speculate that having several TE adjunct questions is roughly equivalent to having one TI question, in terms of the textual ground covered. Another reasonable interpretation might be that indirect effects are more the result of processing conditions than of the nature of the questions themselves. Post-questions, regardless of question type, in the absence of a physical review, seem to cause a mental reconsideration of previously read textual material which apparently heightens memory of directly and indirectly questioned material.

Implications for a Curriculum

One ventures into dangerous ground when speculating about how findings about observations taken under controlled experimental conditions translate into teaching practice. However, perhaps a few of these findings have relevance for the classroom.

Homework and Study Guides

The direct effect of homework and study guide questions on learning seems virtually incontrovertible. Assignment of questions which cover the body of what is considered important can be expected to greatly facilitate the learning of that information.

Many parents and teachers will probably not be surprised to learn that students who read simply to answer a question will learn no more than the answer to that question. How should homework questions fit into classroom practice? The evidence seems to suggest that students who read the text first and then read to find answers to their questions will benefit directly and indirectly over students who have no such aid. They will do better not only in answering the questions, but they will also have better memory for the answers than those who do not use the text, or who do not have questions at all.

It appears to be to their advantage that they consult the text as they answer their questions, and that they read the text before answering them. The indirect effect admittedly is a marginal one, but when total learning is considered, the read-first, then look-back-to-answer-questions strategy is the most productive. One thing appears certain, based on the performance of the questions groups when compared to the Read-Only group in this study: Virtually any strategy of question usage is better than no questions at all.

Teachers, aware as they surely are that some students will study no more than the study guide requires, can make one of two adjustments. One thing they can do is caution students that mere attention to study guide questions at the expense of all other textual information will facilitate learning of only the answers to those questions and no more, and that, if tests cover more than that, students who only read to answer the questions will not be prepared for those tests. A second possible adjustment, of course, would be for teachers to begin to test only from the material covered by a study guide. The same caveat would apply to homework questions.

Regular Quizzes

Many teachers will be gratified to know that quizzes directly following assigned readings have both a direct and indirect effect on learning. This will probably not surprise most teachers, because this does have intuitive appeal. Lest these findings are overextended, it must be added that the above results refer to questions which directly followed reading. Such results might not be found under the circumstances of a 24-hour delayed quiz, which is, of course, closer to what the garden variety pop quiz resembles. Perhaps further research can clarify this issue.

One possible adaptation would be to have students study for a quiz, either individually or in groups, during a class period. They can then attempt to predict test questions and set about answering them during class time. At the end of the period (rather than the traditional beginning of the period), quiz the class on what they had been studying. The quiz itself could be expected to have both direct and indirect effects on the students' learning, even without the hypothetically beneficial effects of the study groups during class time. Studying of this nature would, in effect, replicate the procedure that the Lookbacks group followed and could be expected to provide similar benefits.

Implications for Further Research

One future consideration might be for researchers to pay closer attention to what subjects actually do, and consider reporting that as well. As noted above, there can be significant differences between the composition of the groups that researchers assign subjects into and groups that students select themselves into by what they choose to do.

The technology that makes this possible, inexpensive and portable video equipment, of course offers itself as a means for recording an enormous amount of previously unquantified data. The challenge for researchers is to determine which observable behaviors correspond to which covert cognitive processes, and to what extent these observable procedures can be taken to represent those cognitive processes.

It is tempting to learn whether the addition of a daily end-of-the-period quiz to some in-class presentation or in-class study preparation would add anything significant to that day's learning. If these results are to be believed, such an end-of-the-period quiz (instead of the usual beginning-of-the-period time slot) should contribute significantly to learning, even learning not questioned on the quiz. Such a daily measure would also satisfy other desirable instructional requirements such as learning accountability, a record of material covered over a given period, and a record of student progress. Such measures could also be used as dependent measures of other instructional variables under investigation.

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Table 1

Number of Students by Assignment Condition and Question Type in Each Processing Group, by Lesson

Chapter Lesson	Assignment Condition by Question Type by Processing Group									
	Lookbacks Allowed					Same Time				
	TE		TI			TE			TI	
	LB	NL	LB	NL		LB	NL	S	LB	NL	S
Lesson One	18	1	14	7		16	4	18	14	4	15
Lesson Two	16	1	16	5		14	6	19	15	3	16
Lesson Three	17	1	14	7		13	6	19	14	3	17

Note. Students in the Lookbacks (LB) processing group first read the text and then looked back in the text to answer questions. Students in the No-Lookbacks (NL) processing group read the text and then answered from memory without looking back. Students in the Search (S) processing group read the question first and then searched the text for answers.

Table 2

Group Means and Standard Deviations of Lessons Two and Three Criterion Question Performance by Assignment Condition and Processing Group

Treatment			Assignment Condition			
Adjunct Question Type	Criterion Item Type	Effect Type	Lookbacks Not Allowed	Lookbacks Allowed	Same Time	Read Only
TE	Repeated TE	Direct	1.21 (.98)	1.51 (1.97)	1.54 (.88)	.66 (.56)
TE, TI	New TE	Indirect	.87 (.74)	.97 (.83)	.71 (.68)	.66 (.56)
			Processing Group			
			No Lookbacks	Lookbacks	Search	Read Only
TE	Repeated TE	Direct	1.21 (.94)	1.64 (.96)	1.48 (1.0)	.66 (.56)
TE, TI	New TE	Indirect	.92 (.76)	.85 (.75)	.60 (.63)	.66 (.56)
TI	Repeated TI	Direct	2.18 (1.63)	1.67 (1.45)	1.10 (1.02)	21.6 (2.12)
TE	New TI	Indirect	2.17 (1.49)	2.74 (1.71)	2.87 (1.96)	2.16 (2.12)

Note. On repeated items, Read-Only scores are shown for purposes of comparison only. Standard deviations are in parentheses.

Table 3

Means and Standard Deviations of Lesson Four Criterion Question Performance by Assignment Condition and Processing Group

Criterion Item Type	Effect Type	Assignment Condition: Lookbacks Not Allowed	Lookbacks Allowed	Same Time	Read Only
New TE	Indirect Forward	2.78 (1.65)	2.28 (1.57)	2.20 (1.71)	2.11 (1.41)
		Processing Group: No Lookbacks	Lookbacks	Search	Read Only
New TE	Indirect Forward	2.86 (1.73)	2.15 (1.45)	1.99 (1.73)	2.11 (1.41)
New TI	Indirect Forward	2.68 (2.10)	2.26 (2.16)	1.91 (1.93)	2.56 (2.41)

Note. Standard deviations are in parentheses.

Figure 1

How students were assigned into conditions

FOUR ASSIGNMENT CONDITIONS
TWO QUESTION TYPES: TE & TI

LOOKBACKS NOT ALLOWED (LBNA)		LOOKBACKS ALLOWED (LBA)		SAME TIME (ST)		READ ONLY (RO)
TE	TI	TE	TI	TE	TI	NO QUESTIONS

Figure 2

How students were assigned to processing groups

FOUR PROCESSING GROUPS
(WHAT STUDENTS ACTUALLY DID)

NO LOOKBACKS (NL)		LOOKBACKS (LB)		SEARCH (S)		READ ONLY (RO)
TE	TI	TE	TI	TE	TI	NO QUESTIONS